Apparatus and method in the treatment of the stock passed to a headbox of a paper machine or equivalent

The invention relates to an apparatus and a method in the treatment of the stock passed to a headbox of a paper machine or equivalent.

Centrifugal cleaning is needed in paper machines for separation of sand and contaminants. With today's technology, the cleaning efficiency of centrifugal cleaning deteriorates when the fibre consistency of the pulp suspension exceeds 1 %. This limits the increasing of the feed consistency of the stock to be fed to the headbox. In practice, the slotted screen technique has made it unnecessary to use centrifugal cleaning for separating reject fibres, such as shives. A hydrocyclone plant is placed in the short circulation of the paper machine, where the flow rates are high, as high as 2000 l/s. To be operative, centrifugal cleaning requires a pressure difference of 120-150 kPa. In that connection, all (about 5) steps of the hydrocyclone plant require pumps, which represent as much as about 25 % of the energy consumption of the short circulation. At a flow rate of 2000 l/s, the power consumption of centrifugal cleaning is about 1200 kW. A typical amount of fibre reject from centrifugal cleaning is about 0.1 – 0.2 % of production. The loss of the filler pigments coming with coated broke is at its worst about 0.5 % of machine production.

A filler recovery system is often incorporated in connection with the centrifugal cleaning of the short circulation. In addition to filler, the system must also process other rejects, such as fibre reject and sand, coming from the short circulation. In that case, the efficiency of the filler recovery system is not best possible.

Concepts are known in which the cleaning of the stock has been transferred from the short circulation to pulp lines. The consistency (about 3 %) of the broke system is, however, not suitable for separation of sand with hydrocyclones.

When centrifugal cleaning is in the pulp line (e.g. chemical pulp, DIP or TMP), these pulps need not be cleaned again any more, but the debris, sand and non-disintegrating coating sheets of paper coming to the broke system via pulpers should be treated by means of hydrocyclones.

By placing a hydrocyclone plant in accordance with the invention in a broke system line in the short circulation, the problem is solved. The fibre consistency in the headbox can be increased, when needed, to a level of over 2 % without the fibre consistency in the centrifugal cleaning exceeding the limit of 1 %.

The size and the energy consumption of the hydrocyclone plant would be only about one third of the present size and energy consumption. The size is determined based on the maximal broke percentage.

At the same time, better selectivity is achieved in the filler recovery process.

In the invention, a hydrocyclone plant is placed in a stock line which is in the short circulation and uses broke, and it is connected with another stock line, so that the bulk of the stock flow (the purer stock) bypasses centrifugal cleaning.

The proposal reduces the energy consumption of centrifugal cleaning by about 65 %, which means a saving of about 17 % in the energy need of the short circulation. On a large machine the saved power is about 800 kW.

The amount of reject from centrifugal cleaning is reduced to a fraction, which means that the amount of reject from centrifugal cleaning would be in its entirety less than 0.05 % of production. In practice, it could halve the amount of reject in

the area of the paper mill, thus reducing the handling capacity associated with fibre recovery.

The investment in equipment is reduced by about 65 % in centrifugal cleaning and by about 10 % in respect of the short circulation. A hydrocyclone plant is a subprocess that takes up much space. By means of the arrangement in accordance with the invention, the paper machine hall is shortened by 3 m, with the result that the saving in building costs is considerable.

In accordance with the invention, a system is formed that includes at least two stock chests. The first stock chest comprises a stock composition M_1 containing pulp that requires centrifugal cleaning before it is passed to the headbox of the paper machine. The stock composition M_1 contains broke pulp passed from the paper machine and, in addition, it can contain pulp coming from fibre recovery and further mechanical pulp. The second stock chest comprises a stock composition M_2 containing pulp that has already undergone centrifugal cleaning, such as recycled fibre and/or chemical pulp and/or TMP. Thus, it does not contain any broke coming from the paper machine. In the arrangement in accordance with the invention, only the stock M_1 of the first stock chest is treated in the hydrocyclone plant and at least one accept is passed from it into connection with a second stock chest line and its stock M_2. There can be more stock chests than two.

The apparatus in accordance with the invention thus includes a hydrocyclone plant that is much cheaper in capital expenditure and takes up less space than that of the prior art because its capacity need not be as high as that of the prior art arrangements in which all stock is passed through a hydrocyclone plant. In the arrangement in accordance with the invention, it is only the stock M_1 which has come as broke that is passed through the hydrocyclone plant in the short circulation of the headbox.

The apparatus and the method in the treatment of the stock passed to the headbox of a paper machine or equivalent in accordance with the invention is characterized by what is stated in the claims.

In the following, the invention will be described with reference to some advantageous embodiments of the invention shown in the figures of the appended drawings, but the invention is not meant to be exclusively limited to them.

Figure 1A shows a prior art apparatus for passing stock to a headbox of a paper machine.

Figure 1B shows an arrangement in accordance with the invention.

Figure 2A shows a first embodiment of the invention in which broke-containing stock is passed from a first stock chest to a hydrocyclone plant, and in which embodiment the stock is passed through a wire pit.

Figure 2B shows a second embodiment of the invention.

Figure 3 is an illustration of principle of the operation of a hydrocyclone plant.

Fig. 1A shows a prior art stock system in which all stock $M_1 + M_2 + M_3$ is passed to a hydrocyclone plant 20, which means that a high capacity is required from the hydrocyclone plant.

Fig. 1B shows an arrangement in accordance with the invention. A stock chest $10a_1$ contains stock, i.e. a pulp fraction M_1, which contains broke passed from a paper machine and said pulp fraction M_1 is treated in a hydrocyclone plant 20. The cleaned stock, its accepts are passed further into connection with stocks M_2 and M_3 that do not contain broke and further to a headbox 100. The pulp fractions M_2 and M_3 that do not contain broke in stock chests $10a_2$ and $10a_3$ thus bypass the

centrifugal cleaning 20, and the accept of the stock M_1 from the hydrocyclone plant 20 is passed into connection with said stocks M_2 and M_3. The hydrocyclone plant 20 is not required to have as high a capacity as that of the embodiment of Fig. 1A.

In the embodiment of Fig. 2A, stock M_1, or a pulp fraction, of a first stock chest $10a_1$ also comprises a stock composition that requires centrifugal cleaning before it is passed to a headbox of a paper machine. The stock M_1 contains broke coming from the paper machine and, in addition, it may contain pulp coming from fibre recovery, and further mechanical pulp.

Stock M_2 of a second stock chest $10a_2$ comprises a stock composition that has already undergone centrifugal cleaning, such as recycled fibre and/or chemical pulp and/or TMP.

In the embodiment of Fig. 2A, the stock M_1 is passed from the stock chest $10a_1$ through a stock line a_1 to a lower part of a wire pit 11. The line a_1 includes a pump P_1. In the lower part of the wire pit, the stock M_1 is diluted with wire water obtained from a wire section of a paper machine (not shown) along a line d_1 to a consistency required by a hydrocyclone plant 20. A line a_2 leads from the lower part of the wire pit 11 to the suction side of a pump P_2 and a line a_2 leads from the pressure side of the pump P_2 to a first centrifugal cleaning step $20a_1$ of the hydrocyclone plant 20 situated in the short circulation of the paper machine. In the figure, the centrifugal cleaning steps are designated with $20a_1$, $20a_2$, $20a_3$... An accept line from the centrifugal cleaning step $20a_1$ of the hydrocyclone plant 20; a line a_3 is passed further to join a line b_1 of the stock M_2 of the second stock chest $10a_2$ via a mixing device 12. The mixing device 12 is also supplied with wire water from the wire pit 11 along a line e_1 for diluting the stock M_2 to be fed to the headbox 100 to a suitable consistency.

From the upper part of the wire pit 11 there is further a line c_1 for dilution water, said line c_1 including a pump P_3. The line c_1 leads further from the discharge side of the pump P_3 to a deaeration tank $13a_1$. The dilution water passed through the deaeration tank $13a_1$ is conducted further after the deaeration treatment to a discharge line f_1 and further while pumped by a pump P_4 to a machine screen $14a_1$, whose accepted fraction, i.e. accept, is passed to a dilution inlet header J_2 in the headbox 100.

The stock chest $10a_2$ is provided with the line b_1 for the stock and further to the suction side of a pump P_5. On the discharge side of the pump P_5, the line b_1 is connected to the mixing device 12, after which there is a pump P_6 in a line b_2 for pumping the combined stock further along the line b_2 to a deaeration tank $13a_2$, from which a discharge line f_2 leads further to the suction side of a pump P_7. On the discharge side of the pump P_7, in the line f_2 there is a machine screen $14a_2$, from which an accepted fraction, i.e. accept, is passed to a stock inlet header J_1 of the headbox 100.

In the device arrangement in accordance with the invention, only the broke-containing stock M_1 passed from the stock chest $10a_1$ is treated in the hydrocyclone plant 20. An accept line a_3 leads from said hydrocyclone plant further into connection with the stock line b_1 of the stock M_2 of the second stock chest $10a_2$. Since the stock M_2 of the second stock chest $10a_2$ comprises stock that has already previously undergone centrifugal cleaning, said line can be connected directly to the headbox 100 of the paper machine, via its deaeration tank $13a_2$ and machine screen $14a_2$.

In the embodiment of Fig. 2B, stock M_1, i.e. a pulp fraction, of a first stock chest $10a_1$ also comprises a stock composition that requires centrifugal cleaning before it is passed to a headbox of a paper machine. The stock M_1 contains broke coming from the paper machine and it can additionally contain pulp coming from fibre recovery and further mechanical pulp.

Stock M_2 of a second stock chest $10a_2$ comprises pulp that has already undergone centrifugal cleaning, such as recycled fibre and/or chemical pulp and/or TMP.

Also in this embodiment of the invention, only the stock M_1 passed from the stock chest $10a_1$ is treated in a hydrocyclone plant 20. In the embodiment of the figure, the stock is passed from the stock chest $10a_1$ through a line a_1 while pumped by a pump P_{10} to a mixing device 120, in which the stock is diluted to a centrifugal cleaning consistency with wire water obtained from a line f_4, and the stock M_2 is passed further through a line a_2 to the suction side of a pump P_{20}. The line a_2 on the pressure side of the pump P_{20} is connected to the hydrocyclone plant 20 to form the feed of its first centrifugal cleaning step $20a_1$.

In the embodiment of Fig. 2B, the hydrocyclone plant 20 situated in the short circulation of the paper machine includes centrifugal cleaning steps $20a_1$, $20a_2$ and $20a_3$. An accept line a_3 leads further from the first hydrocyclone, i.e. the centrifugal cleaning step $20a_1$ of the hydrocyclone plant 20 into connection with a stock line b_1 of a second stock chest $10a_2$.

In the embodiment, wire water from the paper machine is passed to a wire pit 110 through a line d_1, which wire pit 110 in this embodiment is formed by a planar wire pit structure, a so-called flume, which comprises a horizontal flow path for wire water. Said wire pit 110 removes effectively air in bubble form from the wire water, and pre-deaeration of the wire water is accomplished by means of said wire pit type. The wire water is passed from the wire pit 110 through a discharge line d_2 and a pump P_{30} to a deaeration tank $13a_3$, from which there is further a discharge line f_3 leading into connection with the line b_1 of the stock M_2 of the second stock chest $10a_2$ via a mixing device 12. The line f_4 leads further from the discharge line f_3 of the deaeration tank $13a_3$ into connection with the line a_1 of the stock M_1 of the first stock chest $10a_1$ via the mixing device 120. A branch line f_5 leads further from the line f_3 to a pump P_{40} and further from the pressure side of

the pump P_{40} to a machine screen $14a_3$, which conducts the wire water further as accept from the machine screen $14a_3$ to a dilution water inlet header J_2 of a headbox 100.

The stock M_2 is passed from the stock chest $10a_2$ through a pump P_{50} along the line b_1 to the mixing device 12 in order to be combined with the stock coming as accept along the line a_3 from the hydrocyclone plant 20 and with the dilution water coming along the line f_3. After that the diluted stock is pumped by means of a headbox feed pump P_{60} through a machine screen $14a_4$ to a stock inlet header J_1 of the headbox 100.

As shown in Fig. 3, the hydrocyclone plant 20 includes several centrifugal cleaning steps $20a_1$, $20a_2$, $20a_3$, so that, as shown in the figure, accept from the first step $20a_1$ is passed through the line a_3 further into connection with the line b_1 of the stock M_2 of the second chest $10a_2$. As shown in Fig. 3, the stock is passed through the line a_1 as a feed to the first centrifugal cleaning step of the hydrocyclone plant 20, i.e. to the hydrocyclone $20a_1$. The stock flows along a spiral-shaped path inside the hydrocyclone $20a_1$ and heavier particles separate as reject from the bottom of the hydrocyclone and lighter particles rise as accept further through the line a_3 into the line b_1 of the stock M_2 passed from the second stock chest $10a_2$. There can be several hydrocyclones $20a_1$, $20a_2$, $20a_3$... and the reject from the first hydrocyclone $20a_1$ can be passed further to the second hydrocyclone $20a_2$ as its feed and the accept from it in one embodiment can be passed further to the line b_1 of the stock M_2 of the second stock chest $10a_2$.

The figure shows a headbox 100. The headbox 100 in accordance with the invention is advantageously a so-called dilution headbox, which means that the dilution water passed to the dilution water inlet header J_2 is passed further across the width of the headbox to different points of the stock passed from the stock inlet header J_1. In this way, dilution makes it possible to regulate the basis weight of the web across the width of the web. The dilution water passed from the

dilution water inlet header J_2 is passed to ducts which are provided with dilution water valves, by means of which the supply of dilution water can be regulated as desired across the width of the headbox, thus enabling the basis weight of the web to be regulated to be even across the entire width of the web.

As shown in the figure, the hydrocyclone plant can also include several accept lines, the stock passed through them being conducted into connection with another stock or with stocks passed from other chests. In accordance with the invention, it is also possible to use several stock chests, but in the invention only that stock, such as the broke-containing stock M_1, which shall be treated in the hydrocyclone plant is circulated through the hydrocyclone plant 20. The pulp fraction M_2 which need not be cleaned with hydrocyclones is passed directly to deaeration and, after a machine screen, to the stock inlet header J_1 of the headbox 100. The accept derived from the stock M_1 in the centrifugal cleaning 20 is conducted into connection with said stock.

When the stocks M_1 and M_2 of the chests $10a_1$, $10a_2$ are referred to in this application, it is also possible to call them a pulp fraction M_1 and a pulp fraction M_2. In this application, the paper machine is understood to mean paper, board and tissue machines.

The broke can be formed of paper broke, which can include trimmings or paper passed to a pulper in connection with web breaks.

The present application refers to lines by which are meant stock lines, pipes, ducts along which stock/wire water is passed.